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Issue Brief

Water for Food and Farms: Trends in California, 1960–2022

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California is one of the world's most productive agricultural regions, supplying both U.S. and international markets with more than 350 different farm products. California agriculture produces more than 75% of the nation's fruits and nuts and almost half of its vegetables. It is effectively the nation's sole producer of almonds, artichokes, celery, garlic, honeydews, kiwi, nectarines, olives, clingstone peaches, pistachios, plums, raisins, and walnuts. California also leads the nation in dairy production. In 2024, agricultural production in California was valued at nearly $67.5 billion, representing 12% of the nation's total agricultural production value. Of that amount, agricultural exports generated almost $24 billion, primarily from nuts, dairy products, and wine.[1]

Water plays a critical role in California agriculture; about 92% of California's crops and about 27% of its pastures are irrigated.[2] California irrigates more than any other state in the nation, as shown in Figure 1, reflecting the scale and intensity of its agricultural production. Agricultural water use in California varies from year to year, ranging from a low of about 25.7 million acre-feet (MAF) in 1992 to a high of 37.0 MAF in 2008, a difference of roughly 44%. Weather, irrigated acreage, and crop type all affect year-to-year variability in agricultural water use, though differing modeling assumptions about water use rates also affect these estimates. Agriculture typically uses about 80% of California's developed water supply.[3]

[1] California Department of Food and Agriculture. https://www.cdfa.ca.gov/Statistics/; USDA Economic Research Service. https://www.ers.usda.gov/data-products/agricultural-trade-multipliers.
[2] USDA. *2022 Census of Agriculture*. Table 11. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_State_Level/California/.
[3] Water used by the agricultural and urban sectors constitutes the developed water supply; the developed water supply does not include instream flows, evaporation, or other categories of use. These categories reflect initial water use; for example, people in California's urban sector consume irrigated crops produced in the agricultural sector. For more information on different categories of water use in California, see *Water for Nature and People*. https://pacinst.org/publication/water-for-nature-and-people-trends-in-california-1960-2022/.

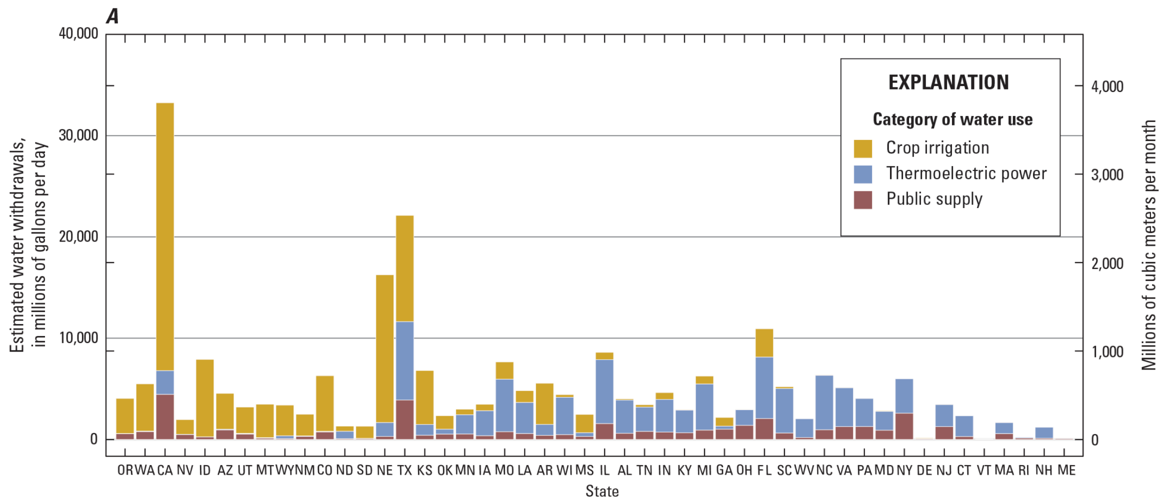

Figure 1. Water Use for Crop Irrigation, Thermoelectric Power, and Public Supply, by State (Listed West to East), United States, 2020.
Source: Medalie et al., 2025.[4]

Climate change-driven hydrologic changes, as well as regulatory changes and rising development pressures, increasingly constrain California's agricultural water use. Climate change has reduced snowpack and runoff while depleting soil moisture and increasing evapotranspiration rates. Long-term groundwater overdraft in regions such as the Central Valley has lowered water tables, increased pumping costs, and contributed to land subsidence. The Sustainable Groundwater Management Act (SGMA), enacted in 2014, limits groundwater extraction rates and is reshaping groundwater management decisions. These pressures constrain agricultural water use, crop choices, and long-term planning.

While agriculture represents only a modest share of California's overall economy, it plays an outsized role in food production, supporting supply chains and contributing to the resilience of the regional, national, and global food system. Given its dominant share of developed water use, it is critical to understand how water is allocated, what drives agricultural production, and how economic forces shape these patterns. **In this brief, we examine water use in California agriculture, changes over time and across crops, and the state's agricultural economics.** In the face of increasing pressures on the state's water resources and systems, we offer this analysis to equip researchers, policymakers, advocates, and other stakeholders with the information they need to drive meaningful policy change to strengthen agricultural resilience in the face of a changing climate.

[4] Medalie, L., A. E. Galanter, A. J. Martinez, A. A. Archer, C. L. Luukkonen, M. A. Harris, and J. V. Haynes. 2025. "Chapter D: Water Use Across the Conterminous United States, Water Years 2010– 20." U.S. Geological Survey Integrated Water Availability Assessment—2010–20. U.S. Geological Survey Professional Paper 1894–D. https://doi.org/10.3133/pp1894D.

Understanding the Data

This brief relies on water use estimates developed by California's Department of Water Resources (DWR), as well as reports and data from the California Department of Food and Agriculture (CDFA), the U.S. Department of Agriculture (USDA), and the California Agricultural Issues Lab (CAIL) at UC Davis. DWR publishes total annual agricultural water use estimates in the *California Water Plan* every five years and makes them available through the California Open Data Portal.[5] DWR also publishes annual agricultural water use data disaggregated by crop type.[6] We use this information to assess crop-specific trends in irrigated acreage and water use. While total agricultural water use is available from 1960 to 2022, crop-specific trends are available from 1998 to 2022 and irrigated acreage by crop is available from 1988 to 2022.

DWR uses the term "applied water," which describes the water delivered to the intake of a water supplier's system, a factory, or a farm headgate. It includes water withdrawn from a water source, usually surface or groundwater, minus any seepage or evaporation from reservoirs and canals (i.e., conveyance losses) prior to delivery.[7] "Applied water" includes both consumptive uses (water that is evaporated, transpired, or incorporated into a crop or product) and non-consumptive uses (water that returns to rivers, groundwater, or other parts of the system). Because applied water does not distinguish between these types of use, estimates of agricultural water use do not represent the volume of water permanently removed from the system. For the purposes of this brief, we use the term "water use" to refer to "applied water" in agricultural settings; it includes water from all sources. This brief focuses on changes in the quantity of agricultural water use in California over time. While water quality and its relationship to agricultural water use are important considerations, they are beyond the scope of this analysis. It is important to note that agricultural return flows can be a significant source of water pollution, including pesticides, nutrients, salts, trace elements, sediments, animal waste, and thermal pollution. In some areas, such

[5] DWR reported total agricultural water use through *Bulletin 160* for the years 1960, 1967, 1972, 1980, 1985, 1990, and 1995. Annual water use data are available for 1998–2022; DWR publishes these data in the *California Water Plan* at https://water.ca.gov/programs/california-water-plan and posts them on the California Open Data Portal at https://data.ca.gov/.

[6] Crop-specific trends are available for 1998–2022 at https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates.

[7] DWR notes that "applied water" is greater than "consumptive use" because it includes consumptive use, reuse, and some outflows, though "applied water" does not account for conveyance losses or reservoir evaporation. In some areas (such as the Upper Colorado River basin), net reservoir evaporative losses are allocated proportionately to water users. DWR previously estimated total California reservoir evaporation at about 2.4 MAF per year, about 8% of total agricultural and urban consumptive use. More than half of this reservoir evaporation occurs in the Sacramento and San Joaquin hydrologic regions. Due to staffing reductions, DWR now estimates and aggregates reservoir evaporation into a larger residual term. See California Department of Water Resources. 2024. *California Water Plan Update 2023 Water Balances Supporting Document*. August 2024.

as the west side of the San Joaquin Valley, significant downstream water quality impacts have led to agricultural land being taken out of production.

California's agricultural water use is not directly measured at the state level; rather, it is modeled by DWR based on several factors, including crop type, irrigated acreage, crop coefficients, weather conditions, and assumed irrigation efficiencies. Crop acreage is estimated from remote sensing land use surveys, which are then verified and validated. Estimates of agricultural water use represent the quantity of water delivered to a farm headgate for crop evapotranspiration, leaching, frost protection, and pre-irrigation, as well as applied water for groundwater recharge.

While DWR's estimates represent the most comprehensive statewide accounting of water use currently available, they have important limitations. Since much of the agricultural water use is modeled, small changes in assumptions about irrigation efficiency or crop needs can impact estimates at regional and statewide scales. As a result, findings presented here should be interpreted as estimates rather than as precise, measured quantities. Additionally, this analysis focuses on total agricultural water use and does not account for shifts in water supply sources; the share of water supplied by surface water versus groundwater varies across regions and over time. More and better data are needed to assess these changes.

Economic information about California's agriculture was derived from information published by the USDA's Economic Research Service (USDA ERS) and CDFA. USDA releases farm income and balance sheet information three times annually, providing forecasts, estimates, and updates coordinated with other key releases. This information is available from 1929 to 2024. Information on employment within the agricultural sector is from California's Labor Market Information Division (LMID), housed within the state's Employment Development Department (EDD).

Trends in Agricultural Water Use

Agricultural water use varies from year to year, ranging from a low of 25.7 MAF in 1992 to a high of 37.0 MAF in 2008, as seen in Figure 2. Weather is a major factor in year-to-year variability in water use, with cooler, wetter conditions generally reducing agricultural water use and hotter, drier conditions increasing it. Over the longer term, water use rose from 1960 to 1980, declined through the early 1990s, then increased 44% between 1992 and 2007. **Since 2007, agricultural water use has declined by an average of 0.27 MAF per year, reaching 31.5 MAF in 2022.** While agricultural water use increases in times of drought, the peak is lower each time. However, a lack of long-term data challenges efforts to determine whether this recent decline is a persistent trend

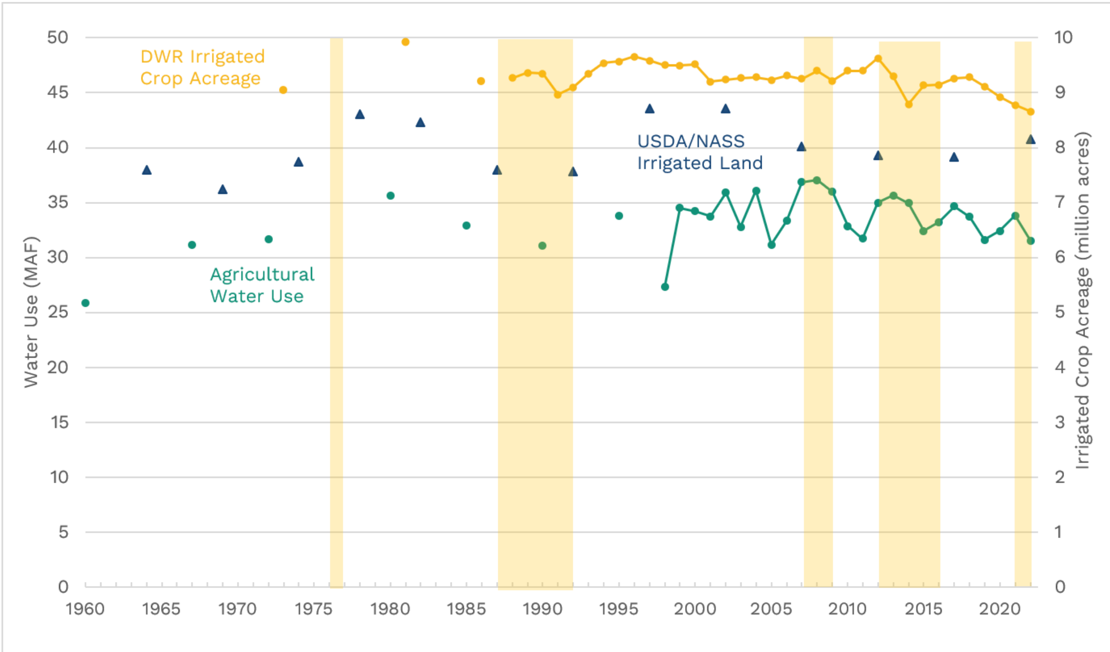

Figure 2. Irrigated Crop Acreage and Water Use for Agriculture, California, 1960–2022.
Note: DWR irrigated acreage values include multi-cropping. DWR irrigated acreage data are only available from 1973. Shaded areas represent statewide droughts.
Data Sources: DWR. USDA/NASS.

DWR reported irrigated crop acreage for the years 1973, 1981, 1986, and 1988–2022. This metric can count the same land more than once when multiple crops are grown on a field within a year (for example, winter vegetables followed by summer alfalfa).[8] The USDA agricultural census, typically conducted every five years, reports the total amount of irrigated land (that is, the net irrigated acreage after accounting for multi-cropping), as well as total harvested irrigated cropland. Comparing these datasets helps distinguish changes in cropping intensity from changes in the total amount of irrigated land. Figure 2 shows the difference between DWR's irrigated crop acreage and the lower total amount of irrigated land as reported by USDA.

According to DWR data, total irrigated crop acreage has varied by just over 10% since the early 1970s, ranging from 8.9 million to 9.9 million acres and averaging 9.3 million acres. According to USDA, the amount of irrigated farmland varied from 7.6 to 8.7 million acres from the early 1970s to 2022. The reported amount in 2022 was about the same as the average over that period. This relative stability in irrigated acreage

[8] DWR began reporting multi-cropped acreage totals in 1998. For the period 1998–2022 (except for 2017, when data were not available), DWR reports an annual average of about 746,000 multi-cropped acres, or about 8% of total reported irrigated acreage. Reported multi-cropped acreage increased to almost 1.6 million acres in 2022.

occurred despite varying trends within types of agricultural land. According to the California Department of Conservation, between 1984 and 2018, the state lost more than 1.6 million acres of farm and grazing land, with over three-quarters of that loss attributable to urbanization.[9] The differences between the DWR and USDA values reflect different accounting methods and highlight the difficulty in determining actual values.

At the same time, the economic value of the agricultural sector has grown substantially, rising from $29 billion in 1960 to double that amount by 2010, and then increasing more gradually to reach a new high of $70.4 billion in 2024 (adjusted for inflation). Several factors shape the interconnected dynamics of water use, acreage, and economic value. The expansion of permanent crops, changing climate patterns, increased exports, increased efficiency across certain sectors, increased crop yields, regulatory changes, and changes in labor availability all contribute to these trends.

The Economics of Agriculture

California agriculture creates significant value by producing food and fiber, supporting critical supply chains, providing jobs, preserving open space, sustaining habitat for many species, and contributing cultural benefits. This section highlights key economic indicators related to agricultural water use.

The Economic Footprint of Water

One measure of agricultural water use is the "economic productivity" of water — the revenue produced per unit of water applied to the crop. Figure 3 shows the gross revenue added to the U.S. economy for crop production in California per acre-foot of water applied to crops between 1960 and 2022. All values have been adjusted for inflation and are shown in 2026 dollars. This metric demonstrates how the revenue associated with a single unit of water has increased over time. **In 1960, an acre-foot of water generated an average of $650 in agricultural revenue; by 2022, that figure more than doubled, reaching approximately $1,400 per acre-foot.**

This measure of economic productivity also reflects trends in applied water and irrigated acreage across crops. Water use has shifted toward higher-value, more water-intensive perennial crops that generate higher economic returns. Improvements in irrigation efficiency along with factors such as improved yields and management

[9] See California Department of Conservation Farmland Mapping and Monitoring Program data at https://www.conservation.ca.gov/dlrp/fmmp.

decisions across the agricultural sector have further contributed to higher economic output per unit of water.

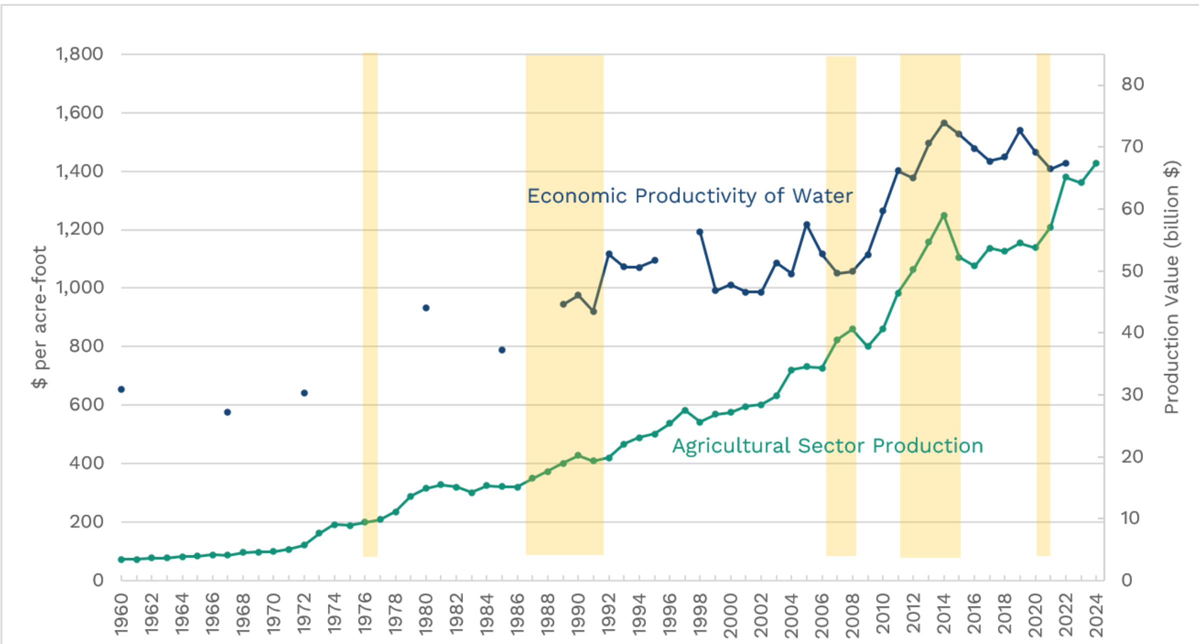

Figure 3. Economic Productivity of Water in California Agriculture, 1960–2022
Note: Shaded areas represent statewide droughts. Values are in constant 2026 dollars.
Data Sources: Water use data from DWR. Economic data from USDA/ERS.

In the early 1960s, agriculture accounted for approximately 5.5% of California's GDP. By 2024, as the state's economy expanded and became more diversified, this share had declined to 1.7%. At the same time, California agriculture remains highly significant at the national scale, contributing about 12% of total U.S. agricultural production. California agriculture produces more than 75% of the nation's fruits and nuts and almost half of its vegetables. It is effectively the nation's sole producer of almonds, artichokes, celery, garlic, honeydews, kiwi, nectarines, olives, clingstone peaches, pistachios, plums, raisins, and walnuts. California also leads the nation in dairy production. Southern California enjoys temperate winter growing conditions, enabling the region to meet market demands for certain crops such as salad greens.

California is a leading agricultural exporter, generating $23.8 billion in revenue in 2024. This was a 6.1% increase from 2023 and a 14.6% increase relative to 2014. California accounts for a disproportionate share of U.S. agricultural exports, representing 13.5% of the national total in 2024. Exports were concentrated in a small set of high-value commodities, led by almonds ($4.95 billion), pistachios ($2.93

billion), dairy ($2.60 billion), wine ($1.08 billion), and walnuts ($0.92 billion) in 2024. Figure 4 shows growing exports of almonds, pistachios, and dairy products contributing to nearly doubling the state's total export value. Globally, export markets are geographically concentrated, with the top 10 destinations, including Canada, the European Union, Mexico, and China, accounting for roughly two-thirds (66.8%) of total export value.

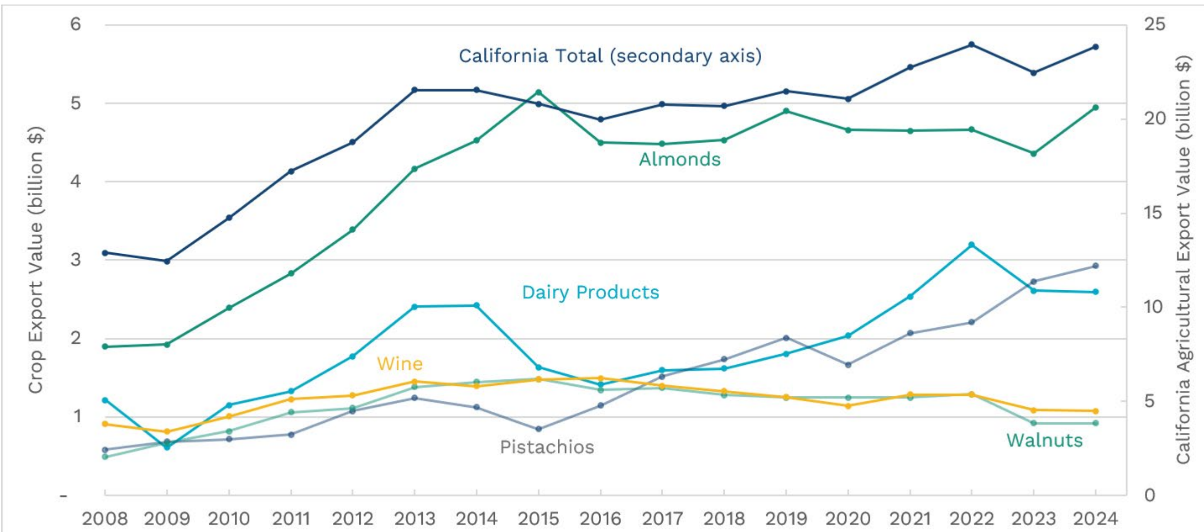

Figure 4. California Agricultural Export Values for the State and the Top Five Agricultural Commodities (Almonds, Pistachios, Dairy Products, Wine, and Walnuts), 2008–2024

Data Source: CDFA.

Agricultural Employment

Agriculture is also a critical source of employment. The sector supports a broad labor force spanning on-farm work, transportation, distribution, and related industries. California agriculture has recently supported an average of 414,000 jobs, though this varies about 50% by season, from recent winter lows of about 315,000 jobs to summer highs of about 480,000. This represents about 2.2% of California's total employment. Orchard, vegetable, and vineyard crops tend to be labor-intensive, especially relative to field crops. Technological improvements and mechanization have reduced labor requirements, though higher-revenue crops continue to be associated with higher labor costs, on average. Factors such as climate impacts, economic conditions, immigration enforcement, and crop and land-use choices can have significant regional employment impacts even when statewide agricultural revenues remain strong. These dynamics are especially important in California, where agriculture plays an outsized role in local economies within the Central Valley and other rural regions.

Farm Size

The USDA Census of Agriculture reported 63,134 farms and about 24.2 million acres in farms in California in 2022, down from 87,991 farms and almost 28.8 million acres in farms in 1997. Over this period, average farm size increased from 327 to 383 acres, reflecting a general consolidation of agricultural production into fewer but larger operations. Ownership patterns also shifted during this period. The total number of family farms decreased from about 69,000 in 1997 to about 45,000 in 2022, while the number of corporate farms increased from about 5,500 to about 8,000.[10] Of these 8,000 corporate farms, 1,539 (2.4% of the total number of California farms) were non-family held corporations, with an average farm size of 684 acres, roughly triple the size of the average non-corporate family farm. **Farm sales data show that a relatively small share of farms accounts for most agricultural production.** In 2022, California had 10,660 farms (about 17% of the total number of farms) with agricultural product sales greater than $500,000 compared to 32,174 (51%) with sales less than $25,000 and 11,100 (about 18%) with sales less than $1,000. Many irrigated farms also generate relatively small sales volumes. In 2023, about 39% of California's total number of farms with irrigation had agricultural product sales of less than $25,000.[11] These farms irrigated almost 318,000 acres and applied a total of 766,000 AF of surface and groundwater.[12]

Trends in Crop Types

Irrigated acreage and water use have shifted notably across crop types over the past two decades (Figure 5 and Figure 6). Here, we look at trends among four major crop categories: field, vegetable, orchard, and vineyard. Field crops are grown in open fields, typically on an annual basis, and include alfalfa, wheat, and cotton. Vegetable crops are also typically grown on an annual basis and include lettuce, tomatoes, broccoli, and many others. Orchard crops produce fruits and nuts over multiple years. In California, these are primarily almonds and pistachios, followed by many types of citrus. Vineyard crops produce wine and table grapes as well as raisins. Unlike some field and most vegetable crops, vineyard and orchard crops live for many years once planted and typically require several years to reach productivity.

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[10] USDA. *2022 Census of Agriculture*. Table 74. Summary by Legal Status for Tax Purposes. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_State_Level/California/st06_1_074_074.pdf.

[11] Note that irrigated farms represent about 45% of the 2022 number of farms with sales less than $25,000.

[12] USDA. *2023 Irrigation and Water Survey* (formerly called the *Farm and Ranch Irrigation Survey*). Table 23. https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/Farm_and_Ranch_Irrigation_Survey/fris_1_023_023.pdf. The *2022 Census of Agriculture* does not report water use, while the 2023 survey's lowest sales category is "less than $25,000."

Figure 5 shows a decline in irrigated crop acreage during recent droughts and an overall shift from field crops to orchards. **Between 1988 and 2022,** the years for which this information is available, **irrigated acreage for field and vegetable crops declined by 40% and 12%, respectively, while orchard crop acreage doubled and vineyard acreage increased by 2%.** More recent trends reinforce this shift. Between 2012 and 2022, field crop acreage declined by just over 1.5 million acres, while orchard acreage increased by a comparable amount. By 2022, orchard crops occupied approximately 3.3 million irrigated acres, accounting for more than one-third of the state's total. Orchard and vineyard crops require higher capital investment and longer periods before generating economic returns than field crops, so growers tend to prioritize irrigating orchards. This long-term irrigation requirement can be seen as a type of "demand hardening," due to the costs associated with curtailing irrigation.

Across crop types, water use trends mirror those observed in irrigated acreage (Figure 6). Between 1998 and 2022, water use for field and vegetable crops declined by 21% and 33%, respectively, while water use for orchard and vineyard crops increased by approximately 175% and 120%, respectively, over the same period. These trends are summarized in Table 1. In the past decade, these dynamics were more pronounced. Water use for orchard crops increased from 7.4 MAF in 2010 to 12.7 MAF in 2022, a rise of 71%. Similarly, between 2010 and 2022, water use for vineyard crops rose by 63%, an increase of about 1 MAF. In contrast, water use for field crops declined steeply after 2008, with the most pronounced reductions occurring through 2011 and continuing more gradually thereafter.

Table 1. Changes in Applied Irrigation Water Use by Crop Type, 1998–2022.

Crop Type	Change in Applied Water Use, 1998–2022
Field crops	−21%
Vegetables	−33%
Vineyards	+120%
Orchards	+175%

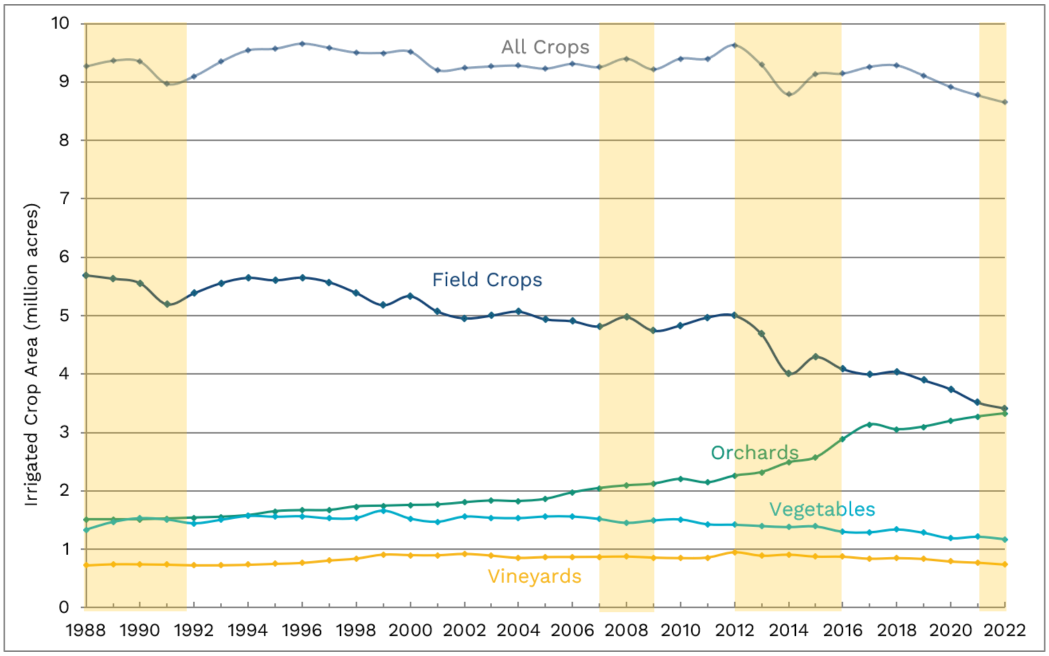

Figure 5. Irrigated Acreage by Major Crop Type, California, 1988–2022.
Note: Shaded areas represent statewide droughts.
Data Source: DWR.

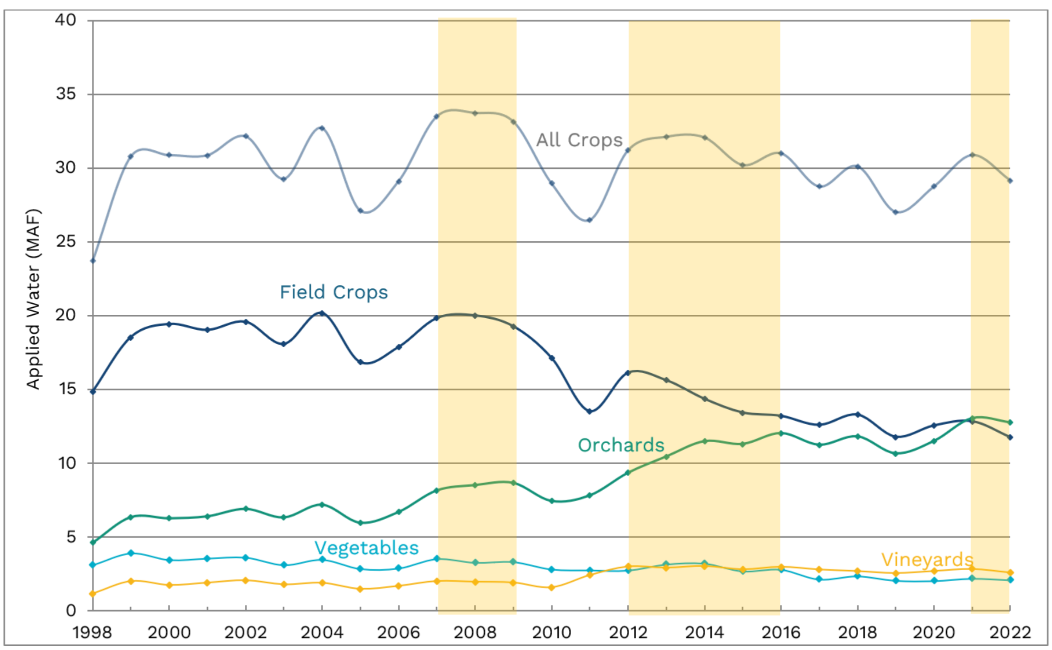

Figure 6. Applied Water by Major Crop Type, California, 1998–2022
Note: Shaded areas represent statewide droughts.
Data Source: DWR.

We also assessed applied water per acre, which provides a useful indicator of water use intensity across major crop types (Figure 7). Changes in this metric can reflect a range of factors, including irrigation technologies and management practices, differences in crop water requirements, weather and climate conditions, and the geographic distribution of production. For example, expansion of crop acreage into hotter or drier regions may increase average water use per acre even if irrigation efficiency improves or remains unchanged. To control for the different water needs among crops, we assess trends within each crop instead of across crops. Here, we use a crop from each category (field, orchard, vegetable, vineyard) to study trends in applied water per acre. These are irrigated pasture (field), almonds and pistachios (orchard), onions and garlic (vegetable), and vineyards.

During the first 12 years of available data, trends are broadly similar across crops: modest year-to-year variability paired with a slight overall increase. There was a sharp increase in water use between 2012 and 2014, coinciding with the onset of a major statewide drought. During this period, applied water per acre rose substantially, by 23% for onions and garlic, 21% for almonds and pistachios, and 9% for pasture. This increase is likely due to increased irrigation demands under hotter, drier conditions.[13] After 2014, applied water per acre for these three crop types began to decline, likely as water availability decreased as the drought intensified. By 2017, applied water per acre for orchards, field crops, and vegetables reached lows comparable to those seen in the mid-2000s. In contrast, vineyard water use continued to climb, with a further 40% increase between 2014 and 2017. Since then, applied water per acre has continued to rise, with a small decline in 2022.

[13] This is consistent with findings from Moyers et al. (2024), which show that crops in the San Joaquin Valley are subject to an “invisible water surcharge” because warmer temperatures and drier air cause crops to need more water than they used to. See https://doi.org/10.1371/journal.pwat.0000184.

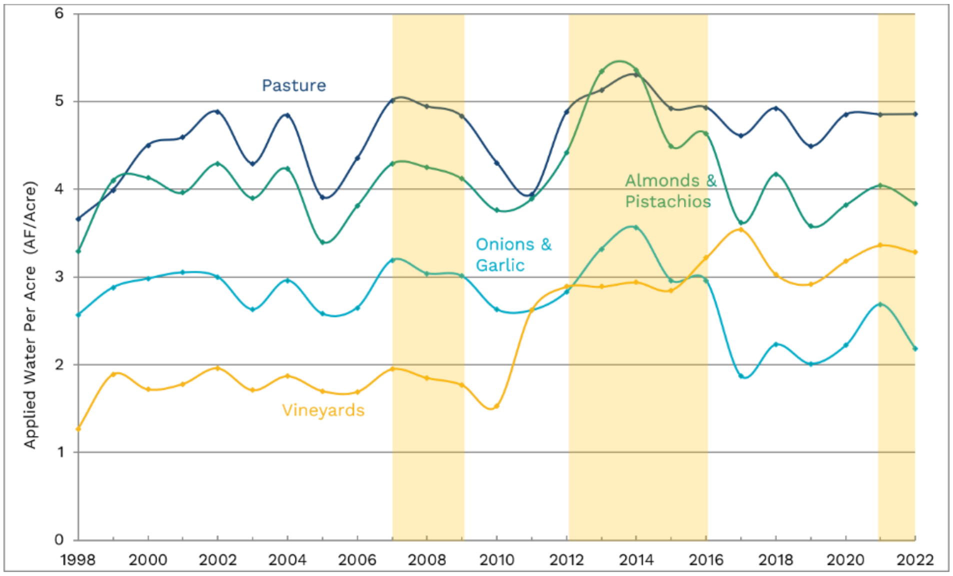

Figure 7. Applied Water per Acre for Representative Crops (Orchard - Almonds and Pistachios, Field - Pasture, Vegetable - Onions and Garlic, and Vineyards), California, 1998–2022.

Note: Shaded areas represent statewide droughts.

Data Source: DWR.

Overall, irrigated crop acreage and water use have shifted toward permanent crops such as orchards and vineyards, a trend driven in part by land values, market forces, and the higher economic returns per unit of water associated with these crops. This expansion of more water-intensive crops, coupled with increasingly hot, dry conditions, has increased pressure on water resources, while improvements in irrigation efficiency have helped mitigate this pressure.[14] Between 1991 and 2021, the share of irrigated acreage using low-volume, high-efficiency systems increased from 15% to 53%, while the share using lower-efficiency surface irrigation fell from 67% to 26%.[15] These advances have helped reduce applied water per acre while maintaining crop productivity, highlighting the important role of efficient irrigation practices in managing agricultural water demand.

HIGHLIGHT: Almonds and Pistachios

Between 1988 and 2022, almonds and pistachios experienced substantial growth in irrigated acreage, water use, and economic value (Figure 8). DWR reports combined data for these two crops, while CDFA reports acreage and revenue for each individual

[14] This pattern is consistent with findings from Marston and Konar (2017) showing that, during California's 2012–2016 statewide drought, harvested farmland declined by 12% while the total agricultural water footprint nevertheless increased by 3%. See https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2016WR020251.

[15] California Department of Water Resources. *Statewide Irrigation Systems Methods Survey*. 1991, 2001, 2010, 2016, and 2021. https://lab.data.ca.gov/dataset/statewide-irrigation-systems-methods-survey.

crop.[16] By 2022, these two crops accounted for more than 60% of irrigated acreage and applied water use within orchard crops. Almonds and pistachios used 29% of total agricultural water use and comprised 24% of total (gross) irrigated acreage statewide in 2022. **In 1988, irrigated acreage for almonds and pistachios totaled approximately 500,000 acres. By 2022, this acreage had quadrupled, reaching over 2 million acres.**

Water use grew in kind; total water use for almonds and pistachios quadrupled from 1.8 MAF in 1998 to 7.3 MAF in 2020. However, almond and pistachio farmers have made substantial gains in irrigation efficiency in the last decade, with applied water per acre falling nearly 50% between 2014 and 2020. According to a 2021 survey from DWR, more than 80% of almond and pistachio acreage is irrigated using efficient low-volume systems.[17] While this shift toward more efficient irrigation likely contributed to the dramatic decline in applied water per acre, other factors, such as water availability, may also have played a role.

Almonds and pistachios consistently rank among California's top revenue-generating commodities. In 2024, according to CDFA, almonds were valued at $5.66 billion and pistachios at $2.05 billion. These two crops also rank among the highest in terms of export value. Between 2009 and 2019, an average of 67% of almonds and 72% of pistachios grown in California were exported. Almonds generated $4.95 billion in foreign sales in 2024, 13.5% higher than the previous year and 2.6 times their value in 2008. Pistachios brought in $2.93 billion in 2024, a 7% increase from 2023 and five times higher than their export value in 2008 (all values adjusted for inflation). Ultimately, the strong economic returns from almonds and pistachios have driven substantial growth in acreage devoted to these crops. Although this expansion, combined with increasingly warm and dry conditions, has increased pressure on water demand, substantial reductions in applied water per acre have helped offset some of these effects.

[16] CDFA reports values for "crop year" (almonds and pistachios have different crop years) while DWR reports by water year for both crops, so there are three different sets of data covering slightly different periods of time.
[17] DWR. 2021. *Statewide Irrigation Systems Methods Surveys*. https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Statewide-Irrigation-Systems-Methods-Surveys.

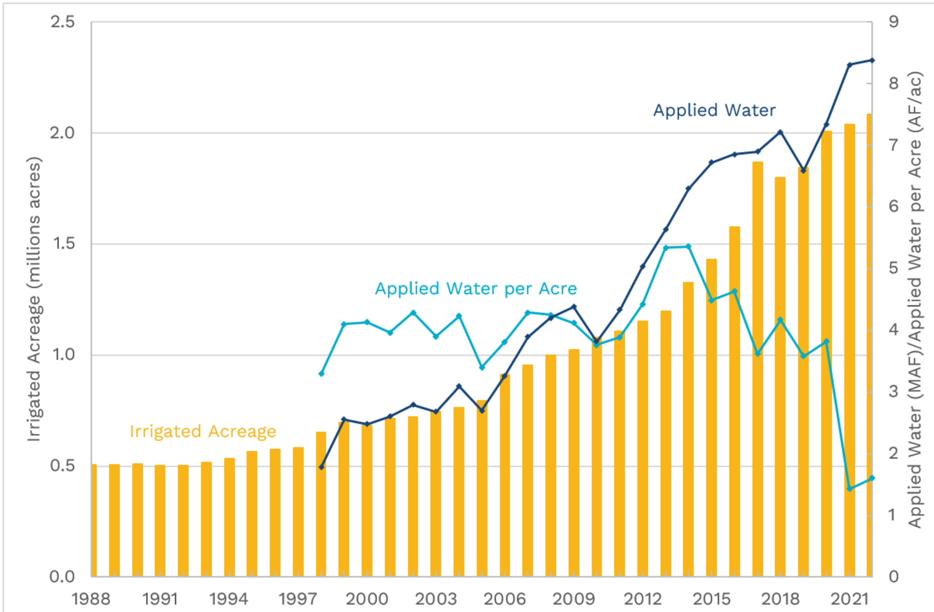

Figure 8. Applied Water, Applied Water per Acre, and Irrigated Acreage for Almonds and Pistachios, California, 1988–2022.
Data Source: DWR.

HIGHLIGHT: Livestock and Dairy

California's dairy industry is the largest in the nation and consistently the largest contributor to the state's agricultural revenue, exceeding $11.5 billion in sales in 2022. Cattle and calves generated another $4 billion in revenue for the state in 2022, rising to $5.4 billion in 2024. **About 15% of the state's irrigated acreage and more than 20% of its applied agricultural water are dedicated to feeding livestock.** Figure 9 shows a greater than 30% decline in acreage irrigated for livestock (defined here as alfalfa and pasture) from 1998 to 2022, from about 2 million acres down to about 1.4 million.[18] Applied water use was more variable over this period, reflecting variable precipitation, but also showed a decline of more than 30%. Despite the decline in acreage and water use, inflation-adjusted revenue for dairy and meat products rose from about $9.8 billion in 1998 to $15.6 billion in 2022.

[18] Macon et al. (2016) estimate a total of 34 million acres of grazed rangelands in California, almost all of which is non-irrigated. Over the course of their lives, livestock may benefit from both irrigated and non-irrigated lands. See https://doi.org/10.1016/j.rala.2016.06.005.

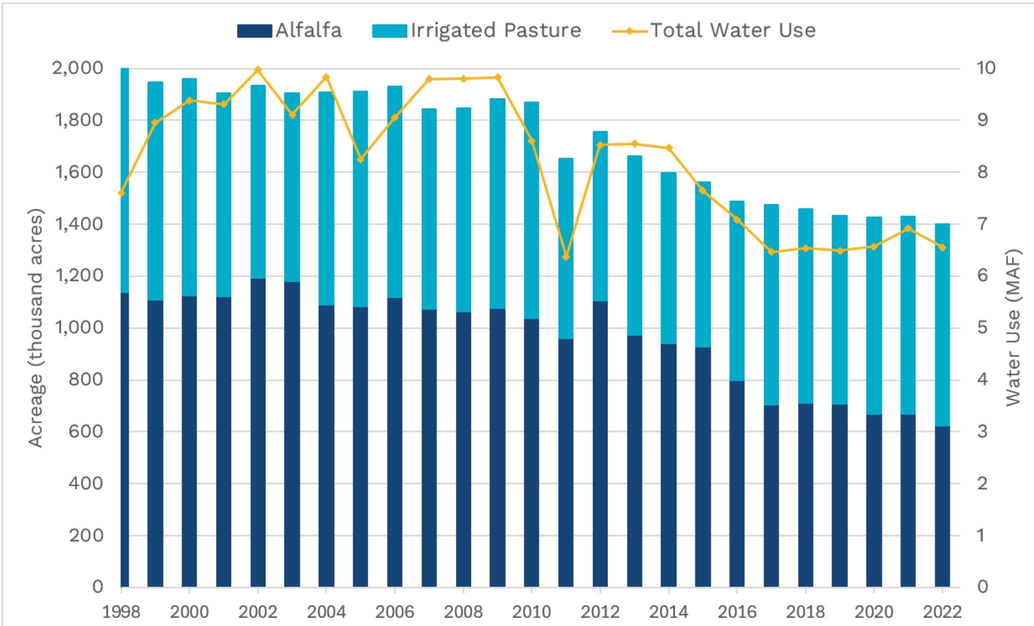

Figure 9. Irrigated Acres and Total Applied Water Dedicated to Feeding Livestock.
Data Sources: DWR. CDFA.

California also irrigates crops to feed livestock in other countries. The ratio of hay production going to export markets has increased over time. In 1999, the California Agricultural Issues Lab (CAIL) at UC Davis first reported the ratio of the quantity of hay exported relative to the quantity of hay produced in California. After remaining relatively stable at around 7% between 1999 and 2008, the export ratio rose sharply beginning in 2009, reaching a peak of 35% in 2022 before declining to 25% in 2024.[19] Although irrigated hay acreage has generally declined since about 2010, combining acreage trends with the export ratio suggests that the area associated with export production increased over the past two decades. **The estimated number of acres growing hay for export increased from about 110,000 in 2008 to a high of about 340,000 in 2017, falling back to about 230,000 in 2024.** Estimating the total applied water use for exported hay requires additional assumptions and is more speculative. The relatively high applied water use rates for alfalfa suggest that water use rose from about 0.6 MAF in 2008 to more than a million acre-feet per year in 2010 and from 2012 to 2024. The value of hay exports also increased alongside these shifts, growing from $186 million in 2008 to a peak of $488 million in 2016 and falling to about $252 million in 2024 (all values adjusted to 2026 dollars). Export revenues per

[19] CAIL data are available at https://cail.ucdavis.edu/california-export-data/. Values for 2014–2024 from CDFA's annual agricultural exports reports are available at https://www.cdfa.ca.gov/Statistics/.

AF of estimated applied water were about 40% higher on average than domestic hay revenues per AF.

HIGHLIGHT: Incentivizing Sustainable Groundwater Use in the Pajaro Valley

The Pajaro Valley near Watsonville is a highly productive agricultural region along the edge of Monterey Bay, spanning parts of Santa Cruz, Monterey, and San Benito counties. Its fertile soils, favorable climate, and agricultural labor force support a strong farming economy dominated by high-value crops such as vegetables, strawberries, and orchard crops. Pajaro Valley offers an instructive case study of local governance addressing diminishing water supply to increase resilience and productivity within an agricultural region.

By the 1980s, DWR had identified the basin as critically overdrafted, with groundwater pumping exceeding natural recharge and contributing to seawater intrusion into the coastal aquifer. In response, the Pajaro Valley Water Management Agency developed a conjunctive-use management program focused on balancing groundwater extraction with alternative supplies, including surface and recycled water. A key strategy has been intensive metering and monitoring of nearly all wells, enabling detailed tracking of water demand and systemwide use.

To fund and incentivize sustainable water use, the agency implemented a voter-approved rate structure in 2010. Within this pricing structure, water users in a designated zone who directly benefited from recycled water deliveries were charged 21% higher pumping fees than users outside the zone. This increased their total cost of groundwater extraction by an estimated 17% once pumping energy costs were included.[20] At the same time, recycled water was priced more competitively, encouraging the transition away from groundwater pumping and helping reduce overdraft. Research evaluating the policy found a 22% reduction in groundwater extraction after the pricing shift, with farmers becoming increasingly responsive to prices over time as they adjusted operations and cropping decisions.[20] By 2024, annual groundwater use had declined by 16% from 2015 levels, providing evidence of continued progress toward stabilizing the basin and mitigating seawater intrusion.

[20] Bruno, Ellen M., Katrina K. Jessoe, and W. Michael Hanemann. 2024. "The Dynamic Impacts of Pricing Groundwater." Journal of the Association of Environmental and Resource Economists 11 (5): September. https://doi.org/10.1086/728988.

Regional Variability

Agricultural water use accounts for 80% of California's developed water supply.[21] While statewide summaries provide a useful overview, regional information helps identify where changes are occurring and how they vary across different parts of the state, which in turn can help inform where policies and programs are likely to be most effective and impactful.

California has 10 hydrologic regions, corresponding to the state's major drainage basins.[22] Four of these regions account for about 83% of the state's irrigated acreage and 90% of its agricultural water use: Tulare Lake (33% of irrigated acreage and 30% of agricultural water use), Sacramento River (21% and 25%, respectively), San Joaquin River (about 23% for both), and Colorado River (7% and 12%, respectively). Economic value varies across these regions as well and is reported by county. In 2023, according to the CDFA, agricultural production was concentrated in a relatively small number of high-producing counties, with Kern, Fresno, Tulare, and Monterey ranking as the state's top agricultural counties by revenue.[23]

There has been a remarkable increase in orchard crop acreage in the Tulare Lake and San Joaquin River hydrologic regions and much slower growth in the Sacramento River hydrologic region, coupled with a significant decline in field crop acreage in all four hydrologic regions (Figure 10 and Figure 11). A detailed assessment of regional agricultural variations in California is beyond the scope of this brief but would improve understanding of trends in agricultural water use and provide greater insight into regional patterns and priorities.

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[21] For more information on different categories of water use in California, see *Water for Nature and People* at https://pacinst.org/publication/water-for-nature-and-people-trends-in-california-1960-2022/.
[22] See https://cww.water.ca.gov/regionscale.
[23] CDFA. *2023–2024 California Agricultural Statistics Review*. www.cdfa.ca.gov/Statistics/PDFs/2023-2024_california_agricultural_statistics_review.pdf.

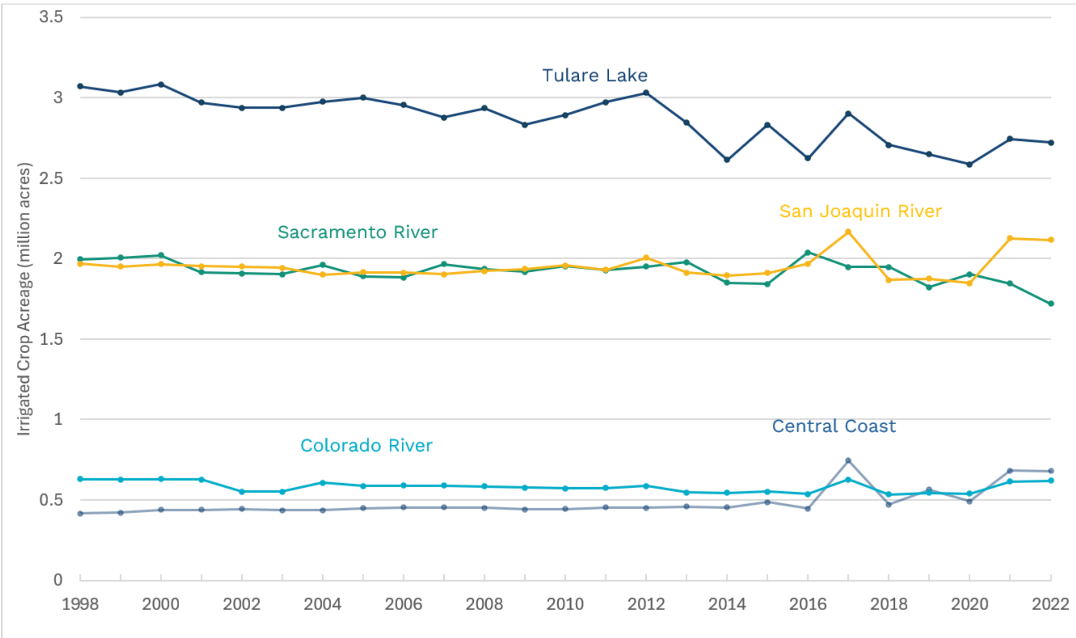

Figure 10. Irrigated Crop Acreage across the Five Major Agricultural Hydrologic Regions in California, 1998–*2022.*
Data Source: DWR.

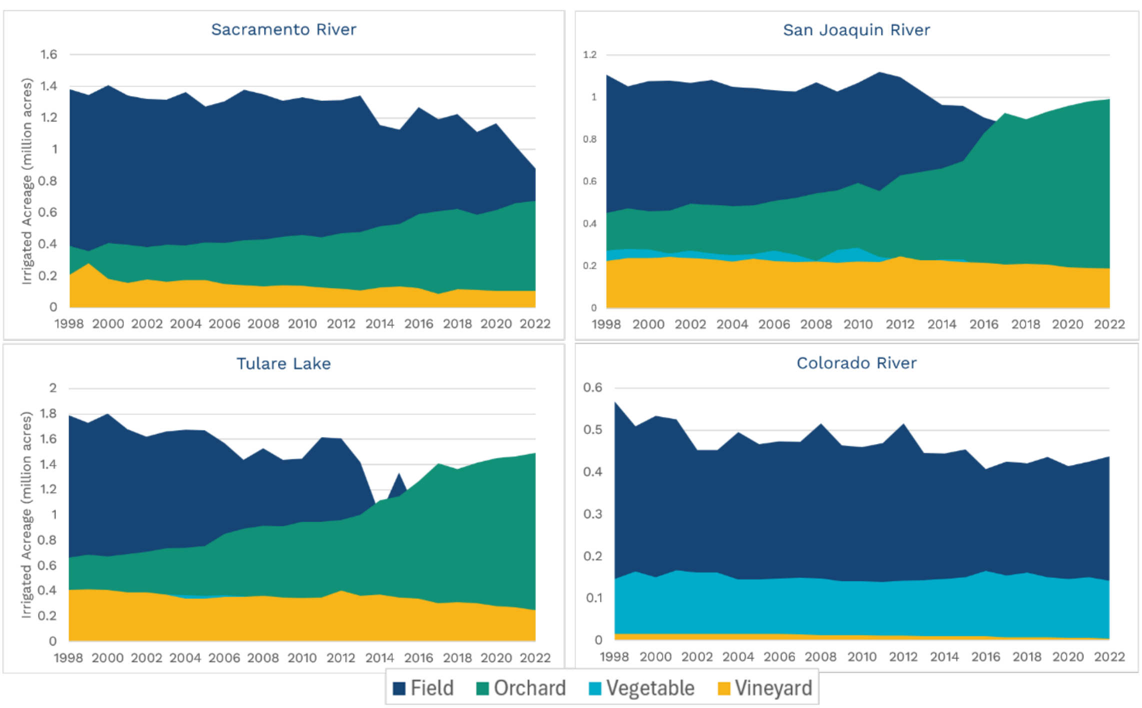

Figure 11. Irrigated Acreage by Crop Type for Four Major Agricultural Regions in California, 1998–2022.
Data Source: DWR.

Conclusion

California agriculture remains one of the most economically productive and globally significant agricultural regions in the world, generating substantial economic value while supporting food production, exports, employment, and rural economies across the state. In 2024, California agricultural production generated nearly $70 billion in revenue and provided over 400,000 jobs. At the same time, California's agricultural sector is undergoing a structural transition. **Irrigated acreage and applied water use have increasingly shifted toward permanent orchard and vineyard crops while field crop acreage and associated water use have declined.** Even as irrigated permanent crops have expanded and drought conditions have become more frequent and severe, improvements in irrigation efficiency along with factors such as improved yield and management decisions across the agricultural sector have helped offset some of these effects and increased the economic productivity of agricultural water over time. The shift from annual field crops to orchards and vineyards has dramatically increased domestic and export revenues, but it has also made agricultural water use less flexible and therefore more vulnerable to water supply constraints.

Understanding how water use varies across crops and regions over time helps identify where California's agricultural systems can be strengthened in the face of a changing climate. Reliable measurement, reporting, and regional analysis are essential for understanding how water is used across crops and hydrologic regions. **California's agricultural future will depend on balancing economic productivity, environmental and social sustainability, and long-term water availability in an increasingly constrained system.** Continued investment in data collection, analysis, and transparent reporting will be critical for supporting informed policymaking and helping California agriculture remain economically viable and adaptable in the decades ahead. We urge policymakers and decision-makers to invest in state staff and resources to strengthen measurement and reporting systems.

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